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ARMY REVERSE ENGINEERING PILOT PROGRAM SAVINGS VALIDATION

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ARMY REVERSE ENGINEERING PILOT PROGRAM SAVINGS VALIDATION

by

V. Sagar Bakhshi

Tracy Worthington

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The pronouns "he," "his," and "him," when used in this publication represent both the masculine and feminine genders unless otherwise specifically stated.

OFFICE OF THE ASSISTANT SECRETARY OF THE ARMY
Army Procurement Research Office
Fort Lee, Virginia 23801-6045

EXECUTIVE SUMMARY

A. BACKGROUND. The Army Materiel Command (AMC) has been assigned the responsibility to establish and monitor the Army reverse engineering program. AMC has implemented the reverse engineering program through selected AMC Major Subordinate Commands (MSCs). The basic AMC plan was (1) select the replenishment parts for reverse engineering, (2) contract out the reverse engineering task, (3) prepare a guidelines and procedures handbook, (4) use the reverse engineering technical data packages (TDPs) to make competitive reprocurements, and (5) have the Army Procurement Research Office (APRO) validate the cost savings estimates. The results of the Army's reverse engineering efforts have been documented in an Army Reverse Engineering Pilot Program (AREPP) Report that was submitted to the Department of Defense on 3 May 1988. Selected MSCs have identified replenishment parts, secured TDPs, and awarded reprocurement contracts.

B. STUDY OBJECTIVE. The objective of this study is to validate the reported AREPP savings.

C. STUDY APPROACH. The approach included a review of the savings methodology and the validation of both the data for the previous procurements under sole source and the savings estimates.

D. SUMMARY AND CONCLUSIONS. APRO and AMC estimates for reverse engineering costs, return on investment (ROI), instant savings, 5-year savings, and life cycle savings differ in magnitude only. APRO estimates are more conservative, but the analysis has shown that savings were achieved from the Army's reverse engineering efforts. The savings achieved from the first procurements after TDPs were developed under the reverse engineering program were almost twice the cost of reverse engineering for those items. In addition the 5-year and life cycle savings estimates show that during the life of these items the savings may be anywhere from 3 to 9 times the cost of the reverse engineering efforts.

A1

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

A. BACKGROUND/PROBLEM.

The Department of Defense Authorization Act of 1985 directed the Secretary of Defense to establish regulatory programs that would provide domestic business concerns with the opportunity to purchase or borrow replenishment parts for the purpose of design replication or modification and subsequent offers to sell interchangeable replenishment parts to the United States. In the spring of 1985, the Deputy Secretary of Defense directed the Military Services and Defense Logistics Agency to initiate implementation of their respective programs. The Department of the Army selected and funded the Army Materiel Command (AMC) to establish and monitor the Army reverse engineering program. Through the efforts of six Competition Management Offices, located at the selected AMC Major Subordinate Commands (MSCs), the Army Reverse Engineering Pilot Program (AREPP) began to move forward.

The basic AMC plan was to select replenishment parts for reverse engineering, contract out the reverse engineering task, prepare a guidelines and procedures handbook, use the TDP developed under this program to make competitive reprocurements, and have the APRO validate the preliminary results. Based on the contents of the handbook, outcomes of the reprocurements, and the APRO validation, AMC will prepare and publish necessary regulations to fully administer the future Army Reverse Engineering program. At the present time, select MSCs have identified replenishment parts, secured TDPs, and awarded reprocurement contracts. The results of their efforts have been documented in an AREPP report that was forwarded to the Department of Defense on 3 May 1988.

The following is an outline of the APRO's plan to validate the reported AREPP savings.

B. **OBJECTIVE**.

The study objective is to validate the reported AREPP savings.

C. **SCOPE**.

The AREPP consisted of two phases. Phase I, called the Vanguard phase, was a coordinated effort by all AMC MSC's to select and reverse engineer spare parts. This phase was coordinated by the Troop Support Command (TROSCOM) and ended 1 October 1986. The Vanguard phase was followed by the Blossom phase, under which all MSC's developed individual reverse engineering programs. The AREPP Report, henceforth referred to as the AMC report, lists the items reverse engineered during these two phases. The present research effort is limited to the validation of the estimated savings for the items procured by using the TDP developed under Vanguard or Blossom phases.

D. **APPROACH**.

The savings estimates validation involves the validation of the data base consisting of the previous procurement history under sole source and the savings methodology. To validate the data base, APRO requested and received historical procurement history from the item managers. APRO also requested each of the following AMC's MSC to provide data for all contracts awarded on or before 1 September 1988 for items procured by using the TDP developed under reverse engineering programs:

1. U.S. Army Armament Munition and Chemical Command (AMCCOM)
2. U.S. Army Aviation Systems Command (AVSCOM)
3. U.S. Army Communications and Electronics Command (CECOM)
4. U.S. Army Tank and Automotive Command (TACOM)
5. U.S. Army Troop Support Command (TROSCOM)

6. U.S. Army Missile Command (MICOM)

Data call letters are enclosed as Appendix A. Telephonic and written responses from six MSC's did not increase the existing data base but validated the reverse engineering items listed in the AMC's report.

Two members of the APRO staff visited AVSCOM and TROSCOM to collect procurement historical data and to understand the reverse engineering program in general and saving methodology in particular.

E. **REPORT ORGANIZATION**.

Chapter II discusses the methodology used to estimate savings and an analysis of (1) the reverse engineering costs, (2) savings estimates for each item procured by using the TDP developed during the reverse engineering program, and (3) return on investment (ROI). Chapter III states the study summary and conclusions.

CHAPTER II

ANALYSIS

A. INTRODUCTION.

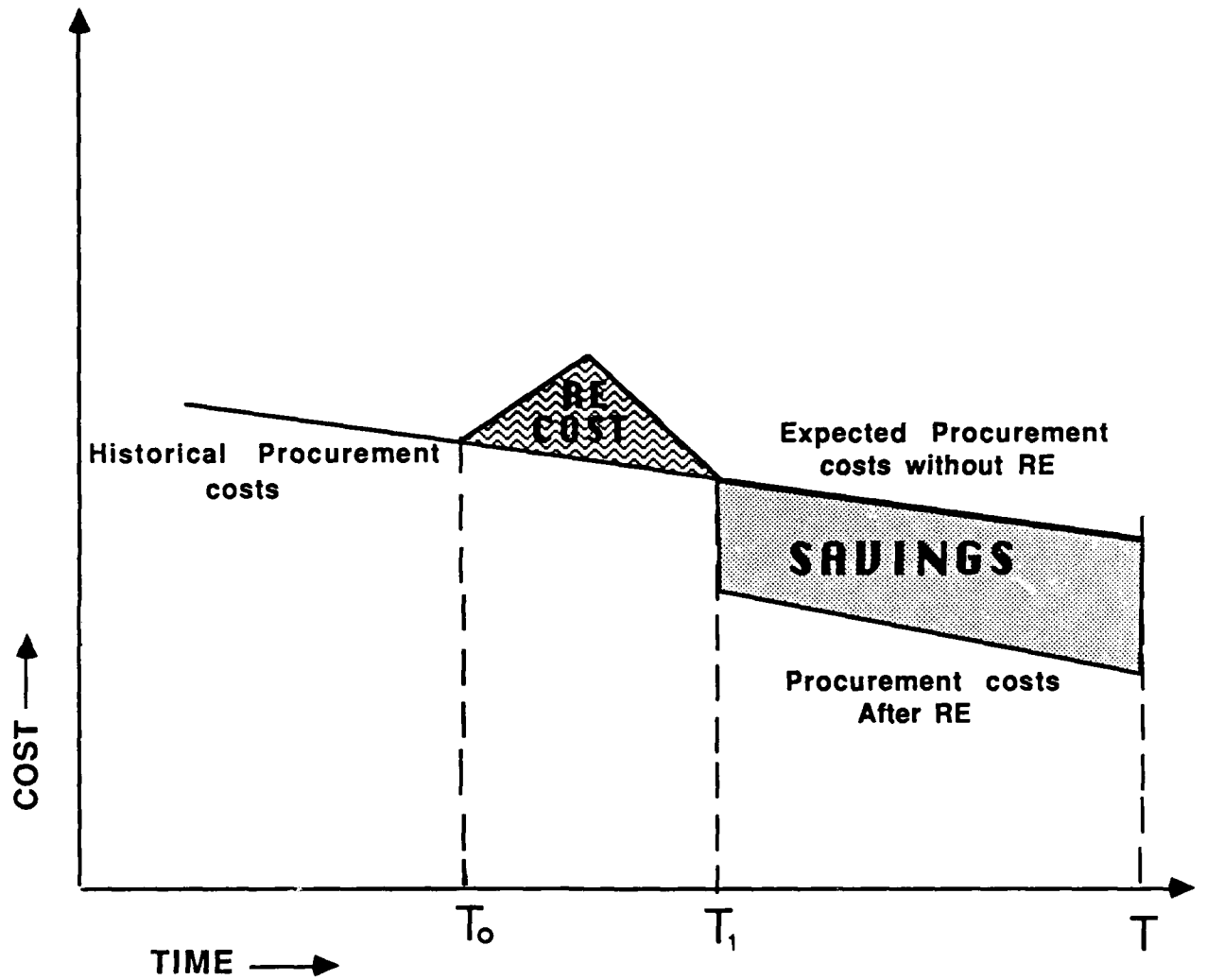
This chapter discusses the savings realized due to the reverse engineering program. This includes an analysis of the savings estimates for the Vanguard and Blossom phases and the methodology used to arrive at the estimated savings. Section B discusses the savings methodology and the technique used to arrive at the expected unit price which the Army would have paid under a sole source environment without a TDP. Section C discusses the savings accrued due to each of the 12 items procured using the TDP developed under the reverse engineering program. Section D summarizes the overall savings estimates and ROI analysis.

B. METHODOLOGY.

The prime measurable benefit of the reverse engineering program is the savings realized during reprocurement of spare parts after Level III TDPs have been developed. This is conceptually illustrated in Figure 1. In the present analysis three kinds of savings are involved: instant savings, 5-year savings, and life cycle savings. Instant savings are realized as a result of the first procurement after a TDP has been developed; whereas 5-year and life cycle savings are the expected savings that will accrue due to the recurring procurements during the next five years and life cycle of the item. The uncertainties involved with each type of savings are different, therefore each is discussed separately.

1. Instant Savings.

To estimate the instant savings one needs to know the actual price paid using the TDP, the estimated price the Government would have paid if



T_o = Start of Reverse Engineering Investments

T_1 = End of Reverse Engineering Investments

T = End of Life Cycle

Figure 1. Conceptual Illustration of Savings Due to Reverse Engineering

there was no TDP, and the quantities procured. The formula for calculating instant savings can be summarized as follows:

Instant Savings = (EUP - AUP) x Q

Where, AUP = Actual Unit Price

EUP = Expected Unit Price

Q = Number of Units Procured

In the above equation AUP and Q are known parameters and EUP is unknown. An estimate of EUP (which is the cost that the Government would have paid a sole source without a TDP) is needed. The accuracy of the estimated savings is dependent upon the accuracy of the EUP.

An estimate of EUP can be obtained from historical data by using one of many analytic techniques, such as learning curve, regression analysis, time series, and averaging methods. Learning Curve (LC) theory is a preferred technique within the Army. The basic principle behind the LC theory is that as the number of units of production doubles, the cost per unit decreases at a constant rate when the production process proceeds without break. The basic hypothesis of continuous production does not seem to be valid for items considered in this study. Much more research is needed to establish whether the LC technique can be used here or not. For the purpose of the present analysis the benefit of projecting EUP using the LC technique does not justify the extra cost necessary to establish the validity of this technique for each case. Thus the LC technique is not used here.

Regression analysis can show a cause and effect relationship between variables, but this method needs a few historical data points. Such data is available only for the item "cargo net". Regression analysis was performed to determine the relationship between the price paid and the quantities procured,

but the analysis did not yield any statistically significant result. This result was expected since under sole source procurement, price is determined by a number of factors in addition to quantity. Thus regression analysis can not be applied in this case.

Time series techniques need a reasonably large historical data base and in this case such a data base is not available.

Averaging methods are suitable for the present analysis, and a moving average of order 1, 2 or 3 can be used to calculate EUP. In most instances historical data is available for only one to three previous procurements. In such cases a moving average of order 1, is used; that is, the last price paid will be taken as the forecast for the next buy. To be more realistic the last price should be adjusted for inflation. However, this adjustment will not be made in the present analysis because using estimated inflation indices adds another dimension of uncertainty to the estimated savings. The net effect of not using an inflation adjustment will be a conservative estimate of the cost savings.

2. 5-year Savings.

The formula used for projecting 5-year savings is:

$$\text{5-year savings} = \sum_{i=1}^{5} (E(i)-P(i)) \times Q(i)$$

Where, $E(i)$ = expected price in i th year

$P(i)$ = the price paid for the previous buy in the i th year

$Q(i)$ = quantities procured during the i th year

In the above equation E(i), P(i), and Q(i) (i=1,2,3,4,5) are unknown and need to be estimated. For this study, a simplifying assumption is made that the difference in E(i) and P(i) will stay constant and is equal to the instant buy. In other words, E(i) and P(i) will increase the same amount and the time value of money will be offset by inflation. To be specific, if a savings of $5.00 per item is realized in the year 1986, then a savings of $5.00 per item will be assumed for the years 87, 88, 89, 90 and 91 in terms of 86 dollars.

The next variable to be estimated is Q(i), the quantities to be procured in the i th year. The estimate of Q(i) varies over time and is determined by the historical demand and the future program needs. This variability in Q(i) can produce different estimates at different times. To illustrate the point, the values of Q(i) as used in the AMC report were calculated from the projected 5-year savings. Projected demands from the Commodity Command and Standard System in August 1988 were obtained for comparison purposes. These figures are shown in Table 2-1. This table shows that estimates of Q(i) for some items has changed by as much as sixty percent, whereas most have stayed roughly the same. This variability can have a significant effect on the projected 5-year and life cycle savings estimates. If the future savings estimates were to be calculated today, then the estimates of Q(i) as given in August 1988 would have to be used. However, for this report the value of Q(i) as used in the AMC report will be adhered to.

3. Life Cycle Savings.

The formula for projecting life cycle savings is the same as projecting 5-year savings except the range of variation for the value of the symbol "i" is from one to the number of years in the life of the item.

Table 2-1
EXPECTED YEARLY DEMAND FOR 12 ITEMS PROCURED USING TDP

ITEM NOMENCLATURE	AMC ESTIMATE	CCSS ESTIMATE	CCSS AS PERCENTAGE OF AMC
Fluid Filter Element	2313	3684	159
Metal Washer	650	866	133
Leveling Jack Assembly	200	84	42
Cargo Net	35	36	103
Pressure Transducer	45	36	80
Roof Lifting Jack	405	306	76
Plastic Washer	626	700	112
End Strainer Assembly	172	168	97
Spacer Plates	1212	1152	95
Halfpenny Washer	3012	3019	100
Spacer Plate	1176	1176	100
Lead Storage Battery	237	?	

C. **CASE PRESENTATION.**

1. Vanguard Phase.

AMC's TROSCOM issued a task order on 2 August 1985 against a competitively awarded indefinite delivery contract to VSE Corporation, Alexandria, VA through Belvoir Research & Development Engineering (RD&E) Center. Initially $943,868.00 were obligated, but according to Belvoir RD&E center, the total amount paid is $1,016,065.00 (Appendix B). The net difference is $72,197.00. The statement of work for the AREPP included: evaluate 120 Government identified candidates, recommend 20 items for follow-on reverse engineering, and perform reverse engineering for 20 selected assemblies. An additional contract requirement was to develop a "How-To" manual on reverse engineering guidelines and procedures. According to the AMC report:

> The Vanguard phase was completed as scheduled (1 October 1986) with 16 items successfully reverse engineered. Level III TDPs for all 16 items have been completed and are being incorporated into solicitations for reprocurement of these replenishment parts on a fully competitive basis. The "How-To" handbook with accompanying AMC wire release (Appendix D) was also completed as scheduled and was published as MIL-HDBK-115 (ME) on 20 April 1987.

As a result of the contract, AMC received 16 Level III TDPs and one "How-To" book. An analysis of reverse engineering costs and cost savings realized due to the reverse engineering program are discussed below.

a. Reverse Engineering Costs. The total reverse engineering cost was $1,050,065. This included the cost of one "How-To" book (MIL-HDBK-115(ME)) which is $156,000. The remaining amount $894,065.00 is attributed to item selection and development of TDPs. This amount is the sum of direct and

indirect costs. Direct cost is the actual contract price to develop a TDP for a particular item. Indirect cost is all other cost to perform the reverse engineering functions, such as in-house support, item selection, and the cost to perform reverse engineering functions on items that were not completed. Table 2-2 shows the total cost to develop TDPs for 16 items. In both APRO and AMC analyses direct costs are the same. Differences in the indirect are explained below:

(1) AMC estimated the total contractor cost for reverse engineering as $443,000, whereas APRO analysis based upon TROSCOM internal audit report raises this to $515,000. (Appendix C)

(2) AMC's estimate of in-house cost is $56,123; whereas APRO's estimate based upon a TROSCOM internal audit report is $34,000. (Appendix C)

(3) The AMC analysis ignored the item selection cost of $345,000. APRO believes that item selection cost cannot be ignored since it is a cost of doing business. In this particular instance, this cost was incurred to obtain the final 16 TDPs. Therefore $345,000 is included in the indirect cost.

b. Cost Savings.

(1) Instant Savings. The seven items which have been procured by using the TDPs developed under the Vanguard phase are: Fluid Filter Element, Metal Washer, Leveling Jack Assembly, Cargo Net, Pressure Transducer, Roof Lifting Jack, and Plastic Washer. For the sake of completeness, the procurement history before and after reverse engineering, instant savings estimates by APRO and AMC, 5-year savings estimates, life cycle savings estimates, and reverse engineering cost for each item is listed separately in Table 1 through Table 7 in Appendix D. A summary and comparison of instant savings estimates between AMC and APRO is given in Table 2-3. Table 2-3 shows that instant savings estimates by AMC and APRO are $894,163 and $458,372

Table 2-2
REVERSE ENGINEERING COST FOR EACH ITEM REVERSE ENGINEERED DURING VANGUARD PHASE (IN DOLLARS)

ITEM NOMENCLATURE	DIRECT COST	INDIRECT COST	TOTAL COST
Nacelle Bolt	$ 1,077	$ 2,039	$ 3,116
Cargo Net	5,384	10,192	15,576
Pressure Transducer	2,153	4,076	6,229
Roof Lifting Jack	32,302	61,150	93,452
Leveling Jack	26,918	50,958	77,876
Plastic Washer	1,077	2,039	3,116
Metal Washer	1,077	2,039	3,116
Engine Container Assembly	21,540	40,777	62,317
Ground Handling Wheel	86,139	163,069	249,208
Fluid Filter Element	26,918	50,958	77,876
Circuit Card Assembly	10,767	20,383	31,150
Power Supply	16,152	30,577	46,729
Electronic Control Unit	37,686	71,343	109,029
Band Assembly	2,153	4,076	6,229
Rotary Pump	21,540	40,777	62,317
Circuit Card Assembly	16,152	30,577	46,729
APRO TOTALS	$309,035	$585,030	$894,065
AMC TOTALS	$309,035	$190,088	$499,123

NOTE: Since no details were available to allocate indirect cost, total indirect cost was distributed proportionately by dollar value of direct cost among all items.

Table 2-3
COMPARISON BETWEEN AMC AND APRO ESTIMATES OF INSTANT SAVINGS FOR VANGUARD PHASE

VANGUARD PHASE	SAVINGS/UNIT AMC	SAVINGS/UNIT APRO	UNITS BOUGHT	INSTANT SAVINGS AMC	INSTANT SAVINGS APRO
Fluid Filter Element	$ 53.50	$ 43.30	8400	$449,400.00*	$363,720.00
Metal Washer	1.67	1.67	1845	3,087.42	3,087.42
Leveling Jack Assembly	160.00	160.00	300	48,000.00	48,000.00
Cargo Net	68.16	68.16	356	24,264.96	20,929.96**
Pressure Transducer	94.10	94.10	28	2,634.80	2,634.80
Roof Lifting Jack	365.00	20.00	1000	365,000.00	20,000.00
Plastic Washer	0.60	Unknown	2959	1,775.40	Unknown
			TOTALS	$894,162.58	$458,372.18

* Due to an arithmetic error, the AMC report lists instant savings as $448,140.

** Instant savings are adjusted by the cost of first article.

respectively. APRO savings estimates for Fluid Filter Element, Roof Lifting Jack, and Plastic Washer are different. The reason for the differences in estimates for these items is explained below:

(a) Fluid Filter Element. The formula for calculating the instant savings is explained in paragraph B.1 and is (EUP-AUP)xQ. The values for AUP and Q are the same for the AMC and APRO estimates. For EUP, AMC assumed a value of $72.70, which was the price paid for the previous buy (1983) at the time of the AMC estimation. However, since that time TROSCOM procured on 24 March 1988 an additional 5000 items from the sole source at $62.50 each. In view of this additional information, the value of EUP is taken as $62.50. This reduces the savings by $10.20 per unit item and since 8400 items were procured, this results in a net difference of 8400 x $10.20 = $85,680.

(b) Roof Lifting Jack. As was the case with the Fluid Filter Element, the difference between AMC and APRO estimates is due to the estimated value of EUP. AMC assumed a value of $504 whereas APRO reduced it to $159 based upon the historical data which indicates that the Army procured 933 items in April 1986 at a unit price of $159. However, the price used by AMC is the listed price in the Army Master Data File (AMDF). The research indicated that the AMDF price for this item is not reliable, as the item was never procured as a spare part at this price. The item came as initial provisioning with the original buy and was not separately priced. Thus $159 is the value of EUP, and this reduces the savings by $345 per unit. Since 1000 units were procured, the net difference in estimates is 1000 x $345 = $345,000.

(c) Plastic Washer. AMC arrived at an estimate for instant savings as $1775 by calculating 25% of the contract price. Since there is no historical data to justify 25%, APRO cannot validate this amount as a reasonable savings estimate.

(2) 5-year and Life Cycle Estimates. Table 2-4 shows the estimated 5-year and life cycle savings for each of the seven items. The differences between AMC and APRO estimates are due to per unit savings in the Fluid Filter Element and Roof Lifting Jack. Table 2-4 shows that according to APRO estimates, the expected savings that may accrue during the next five years and life cycle will be approximately $740,000 and $2.5 million respectively compared to $1.6 million and $5.6 million projected by AMC.

Table 2-4
COMPARISON OF 5 YEAR AND LIFE CYCLE ESTIMATED SAVINGS (IN DOLLARS)

VANGUARD PHASE	5-YEAR AMC	5-YEAR APRO	LIFE CYCLE AMC	LIFE CYCLE APRO
Fluid Filter Element	$ 618,728	$500,765	$1,856,183	$1,502,294
Metal Washer	5,439	5,439	21,754	21,754
Leveling Jack Assembly	160,000	160,000	640,000	640,000
Cargo Net	11,928	11,928	47,712	47,712
Pressure Transducer	21,173	21,173	84,690	84,690
Roof Lifting Jack	739,125	40,500	2,956,500	162,000
Plastic Washer	1,878	Unknown	1,878	Unknown
TOTAL	$1,558,271	$739,805	$5,608,717	$2,458,450

(3) Return on Investment. Table 2-5 shows the ROI analysis for AMC and APRO estimates. The data shows that ROI as calculated from instant savings is 1.7 to 1 for the APRO analysis and 5.8 to 1 for AMC. These results became even more pronounced for 5-year savings, where the AMC ROI is 10.1 to 1 compared to only 2.7 to 1 for the APRO analysis.

It should also be noted that the investments for the reverse engineering program were made in 1985 but the benefits did not accrue until 1987 or 1988 when the procurements were actually made. This difference in time can be reflected in an ROI analysis adjusted for the time value of money. The exact analysis needs detailed knowledge of the time period as to whether the procurement time is contract time, delivery time or payment time. This type of data would require additional research, but for the present analysis such effort is not necessary. However, at the macro level, it can be assumed that the reverse engineering investment was made in 1986 and quantities were procured in 1987. This is an assumption and its net effect will be a more conservative estimate. Also in the methodology discussion, it was explained that savings are in the procurement year dollars. These two assumptions imply that savings are in 1987 dollars and reverse engineering costs are in 1986 dollars. Thus reverse engineering costs need to be adjusted for a one year period. The reverse engineering costs are adjusted for a one year period by the usual discount rate of 10% and the new analysis is shown in Table 2-6. This table shows that instant savings estimates provide a return on investment of 5.2 to 1 for AMC and 1.5 to 1 for APRO, and similar differences exist for 5-year and life cycle savings.

Table 2-5
RETURN ON INVESTMENT WHEN REVERSE ENGINEERING COST IS NOT ADJUSTED FOR TIME VALUE (IN DOLLARS)

	TOTAL REVERSE ENGINEERING COST	SAVING ESTIMATES INSTANT	5-YEAR	LIFE CYCLE
AMC*	$154,774	$892,903	$1,558,327	$5,596,217
APRO	$274,125	$458,372	$ 739,805	$2,458,450
RETURN ON INVESTMENT				
AMC		5.8 to 1	10.1 to 1	36.2 to 1
APRO		1.7 to 1	2.7 to 1	9.0 to 1

*This data is reproduced from the AMC report.

Table 2-6.
RETURN ON INVESTMENT WHEN REVERSE ENGINEERING COST IS ADJUSTED FOR TIME VALUE (IN DOLLARS)

	TOTAL REVERSE ENGINEERING COST	SAVING ESTIMATES INSTANT	5-YEAR	LIFE CYCLE
AMC*	$170,251	$892,903	$1,558,327	$5,596,217
APRO	$301,538	$458,372	$ 739,805	$2,458,450
RETURN ON INVESTMENT				
AMC		5.2 to 1	9.2 to 1	32.9 to 1
APRO		1.5 to 1	2.5 to 1	8.2 to 1

*This data is reproduced from the AMC report.

2. Blossom Phase.

The AMC report lists 33 items which have been reverse engineered during the Blossom Phase. This list is included as Appendix E. Of these 33 items, 5 items have been procured by using the TDPs developed under the reverse engineering program. The procurement history before and after reverse engineering, instant savings estimates by APRO and AMC, 5-year and life cycle savings estimates, and reverse engineering cost for each item is listed separately in Table 8 through Table 12 in Appendix D. An analysis of the reverse engineering costs and cost savings is discussed below.

a. Reverse Engineering Cost. It was pointed out in the previous paragraphs that total reverse engineering cost is the sum of direct and indirect costs. These costs for 5 items which have been procured since they were reverse engineered under the Blossom Phase are given below:

ITEM NOMENCLATURE	DIRECT COST	INDIRECT COST	TOTAL
End Strainer Assembly	$3,045	$882	$3,927
Halfpenny Washer	104	0	104
Lead Storage Battery	442	0	442
Spacer Plate	104	0	104
Spacer Plates	104	0	104
TOTAL	$3,799	$882	$4,681

The four items for which indirect cost is zero were developed in-house. These costs are the same as given by AMC. However, it should be noted that in this analysis, the in-house cost incurred to support an outside contract is considered as an indirect cost, whereas the in-house cost incurred to support in-house reverse engineering efforts were ignored. A more accurate estimate should include in-house costs for both analyses.

b. Cost Savings. A summary and comparison of instant, 5-year, and life cycle savings estimates for the Blossom Phase is given in Table 2-7. It is clear from the table that savings estimates by APRO and AMC for four items are the same. The difference in estimates for the lead storage battery arises due to the fact that there is no historical data on the procurement of this item before reverse engineering. As such the value of EUP in the instant savings estimate formula cannot be ascertained and no savings estimate can be obtained. However, AMC arrived at an estimate for instant savings as $889 by calculating 25% of the contract price. Since there is no historical data to justify 25%, APRO cannot validate this amount as a reasonable savings estimate.

c. Return on Investment. To calculate the return on investment, the following assumptions are made:

(1) Instant savings estimates related to the lead storage battery are not included because these cannot be calculated with any certainty.

(2) No distinction is made between in-house efforts and contracted effort because there is only one item reverse engineered by a contractor.

Based upon these assumptions, the ROI analysis is as follows:

REVERSE ENGINEERING COSTS	INSTANT SAVINGS	5-YEAR SAVINGS	LIFE CYCLE SAVINGS
$4,239	$25,043	$60,814	$120,694
RETURN ON INVESTMENT (rounded)	6 to 1	14 to 1	28 to 1

Table 2-7
SAVINGS ESTIMATES OF BLOSSOM PHASE (IN DOLLARS)

AMC ESTIMATES

ITEM NOMENCLATURE	INSTANT	5-YEAR	LIFE CYCLE
End Strainer Assembly	$11,697	$21,448	$42,897
Halfpenny Washer	607	2,333	3,732
Lead Storage Battery	889	1,784	3,568
Spacer Plate	3,719	9,702	19,404
Spacer Plates	9,020	27,331	54,661
TOTAL	$25,932	$62,598	$124,262

APRO ESTIMATES

ITEM NOMENCLATURE	INSTANT	5-YEAR	LIFE CYCLE
End Strainer Assembly	$11,697	$21,448	$ 42,897
Halfpenny Washer	607	2,333	3,732
Lead Storage Battery	Unknown	Unknown	Unknown
Spacer Plate	3,719	9,702	19,404
Spacer Plates	9,020	27,331	54,661
TOTAL	$25,043	$60,814	$120,694

D. **SUMMARY**.

A summary of the instant, 5-year, and life cycle savings estimates for 12 items procured using the TDP developed under the reverse engineering program is given in Table 2-8. This table also includes the savings estimates as reported by AMC. A comparison of the savings estimates shows that according to APRO estimates, instant savings are approximately $483,000 as compared to approximately $919,000 projected by AMC, and similar differences exist in 5-year and life cycle savings estimates. These differences in estimated savings arise from the differences in the expected unit prices of the fluid filter element and the roof lifting jack, which are explained in detail in paragraph C.1.b.

Table 2-9 summarizes the ROI analysis for both phases. This table also includes the results of AMC's analysis. A simple comparison shows that according to APRO analysis, the instant savings provide a return on investment of 1.7 to 1 as compared to 6.0 to 1 by AMC, and similar disparity exists for 5-year and life cycle estimates. The reasons for these variations are the differences in the estimated instant savings (which are explained in the above paragraph), and the calculation of the reverse engineering costs which are explained in paragraph C.1.a. However, it should be noted that the first procurement recouped almost twice the cost of reverse engineering for these items.

Table 2-9 also shows the ROI for items developed in-house. For these items ROI is substantial and varies from a low of 5.8 to a high of 86.7.

Table 2-8
SAVINGS ESTIMATES FOR ALL 12 ITEMS (IN DOLLARS)

	INSTANT SAVINGS	5-YEAR SAVINGS	LIFE CYCLE SAVINGS
VANGUARD PHASE			
Fluid Filter Element	$363,720	$500,765	$1,502,294
Metal Washer	3,087	5,439	21,754
Leveling Jack Assembly	48,000	160,000	640,000
Cargo Net	20,930	11,928	47,712
Pressure Transducer	2,635	21,173	84,690
Roof Lifting Jack	20,000	40,500	162,000
Plastic Washer	Unknown	Unknown	Unknown
SUBTOTAL	$458,372	$739,805	$2,458,450
BLOSSOM PHASE			
End Strainer Assembly	$ 11,697	$ 21,448	$ 42,897
Spacer Plates	9,020	27,331	54,661
Halfpenny Washer	607	2,333	3,732
Spacer Plate	3,719	9,702	19,404
Lead Storage Battery	Unknown	Unknown	Unknown
SUBTOTAL	$ 25,043	$ 60,814	$ 120,694
TOTAL	$483,415	$ 800,619	$2,579,144
*AMC ESTIMATES	$918,835	$1,620,925	$5,720,479

*This data is reproduced from the AMC report.

Table 2-9
RETURN ON INVESTMENT ANALYSIS FOR INDIVIDUAL ITEMS

VANGUARD PHASE	INSTANT	5-YEAR	LIFE CYCLE
Filter Element Fluid	4.6 to 1	6.4 to 1	19.3 to 1
Metal Washer	1.0 to 1	1.7 to 1	7.0 to 1
Jack Assembly Leveling	0.6 to 1	2.0 to 1	8.2 to 1
Cargo Net	1.6 to 1	0.8 to 1	3.1 to 1
Pressure Transducer	0.4 to 1	3.4 to 1	13.6 to 1
Roof Lifting Jack	0.2 to 1	0.4 to 1	1.8 to 1
Plastic Washer	Unknown	Unknown	Unknown
ROI (All Vanguard Items)	1.7 to 1	2.7 to 1	9.0 to 1
BLOSSOM PHASE			
End Strainer Assembly	2.9 to 1	5.5 to 1	10.9 to 1
BLOSSOM PHASE IN-HOUSE (TROSCOM)			
Spacer Plates	86.7 to 1	262.8 to 1	525.6 to 1
Halfpenny Washer	5.8 to 1	22.4 to 1	35.8 to 1
Spacer Plate	35.7 to 1	93.3 to 1	186.6 to 1
Lead Storage Battery	Unknown	Unknown	Unknown
ROI (all BLOSSOM PHASE in-house items)	42.8 to 1	126.2 to 1	249.3 to 1
ROI (all phases combined)	1.7 to 1	2.8 to 1	9.2 to 1
ROI BY AMC	6.0 to 1	10.0 to 1	36.0 to 1

CHAPTER III

SUMMARY AND CONCLUSIONS

A. **SUMMARY**.

The objective of the Army Reverse Engineering Pilot Program was to select a few items with high potential for return on investment, develop Level III TDPs for those items, and use the TDPs to increase competition and lower spare parts acquisition costs. AMC's report articulates the Army's efforts for their reverse engineering program and documents the estimated cost savings for the 12 items procured by using the TDPs developed under this program. APRO's validation of AMC's efforts provides the following findings:

1. Reverse Engineering Costs.

a. APRO's estimate of the reverse engineering costs for the Vanguard Phase is $894,065 as compared to $499,123 by AMC. There are two reasons for this difference. First, the APRO analysis includes the item selection cost of $345,000 and second, contractor and in-house costs were adjusted to reflect the TROSCOM internal audit findings.

b. Reverse engineering costs are comprised of direct and indirect costs. Items reverse engineered by a contractor incurred indirect costs whereas such costs for in-house efforts were excluded from the analysis.

2. Instant Savings.

The APRO estimate for instant savings is approximately $483,000 as compared to the AMC estimate of approximately $919,000. The difference is attributed to the differences in the expected unit prices of the Fluid Filter Element and Roof Lifting Jack.

3. 5-Year and Life Cycle Savings.

APRO estimates for the 5-year and life cycle savings are approximately $801,000 and $2.6 million respectively compared to $1.6 million and $5.7

million projected by AMC. These differences are due to differences in per unit savings in the Fluid Filter Element and Roof Lifting Jack.

4. Return on Investment.

APRO estimates of ROI for the instant, 5-year and life cycle savings are 1.7 to 1, 2.8 to 1, and 9.2 to 1 respectively as compared to 6.0 to 1, 10.0 to 1, and 36.0 to 1 by AMC. The details of this analysis are given in Table 2-9.

B. **CONCLUSIONS**.

The analysis shows that savings were achieved from the Army's reverse engineering efforts. The savings achieved from the first procurement after TDPs were developed under the reverse engineering program were almost twice the cost of reverse engineering for those items. In addition the 5-year and life cycle savings estimates show that during the life of these items the savings may be anywhere from 3 to 9 times the cost of the reverse engineering efforts. However, it should be noted that future savings estimates depend upon the estimated future demand, which can change.

It should also be noted that the AMC report lists 49 items reverse engineering during the Vanguard and Blossom phases, but only 12 of these have been procured. At present there is no evidence, but it may be that some of these items will never be procured in the future using the TDP developed under the reverse engineering program. In such eventuality the ROI will be less than projected.

BIBLIOGRAPHY

HQ AMC, Army Reverse Engineering Pilot Program Report, Alexandria, VA, 3 May 1988.

APPENDIX A

DATA CALL LETTERS

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
ARMY PROCUREMENT RESEARCH OFFICE
FORT LEE, VIRGINIA 23801-6045

REPLY TO
ATTENTION OF

S: 1 Oct 88

SFRD-KPR (70-61a)

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Data Call For Army Reverse Engineering Pilot Program Validation

1. The Army Procurement Research Office (APRO) has been tasked by the Army Materiel Command to validate reported cost savings for the Army Reverse Engineering Pilot Program.

2. Request data be provided for specific replenishment parts as outlined on the two page enclosure. One Part I form should be prepared for each National Stock Number meeting the stated conditions. Only one Part II form should be prepared for this data call.

3. Requested data should be returned to the following address on or before 1 Oct 88:

Office of the Assistant Secretary of the Army (RDA)
Army Procurement Research Office
ATTN: SFRD-KPR (Mr. Worthington), Bldg 12113
Fort Lee, VA 23801-6045

4. APRO points of contact are Mr. Tracy Worthington or Dr. Sagar Bakhshi at AV687-1148.

Wayne V. Zabel

Encl

WAYNE V. ZABEL
Director, Army Procurement
Research Office

DISTRIBUTION:
COMMANDER,
U.S. Army Troop Support Command, 4300 Goodfellow Road, ATTN: AMSTR-A (Mr. Kerns), St. Louis, MO 63120-1798
U.S. Army Communications and Electronics Command, ATTN: AMSEL-CM-SP (Mr. Faralla), Fort Monmouth, NJ 07703-5000
U.S. Army Armament Munition and Chemical Command, ATTN: AMSMC-SP (Mr. Hamerlinck), Rock Island, IL 61299-6000
U.S. Army Missile Command, ATTN: AMSMI-CM (Mr. Chalmers), Redstone Arsenal, AL 35898-5040
U.S. Army Aviation Systems Command, 4300 Goodfellow Road, ATTN: AMSAV-3BE (Mr. Hauser), St. Louis, MO 63120-1798
U.S. Army Tank and Automotive Command, ATTN: AMSTA-Y (LTC Kammerer), Warren, MI 48397-5000

ARMY REVERSE ENGINEERING PILOT PROGRAM VALIDATION DATA CALL
Part I of II

Provide data only for those replenishment parts that have had technical data packages developed through the reverse engineering process and have had a replenishment contract awarded on or before 1 Sep 88. The assumption has been made that this program can be subdivided into four phases: selection, technical data package development, first article testing, and competitive replenishment. Data requested for the selection phase is noted on Part II. It has also been assumed that separate lots of replenishment parts are managed through the four consecutive phases. If these assumptions are incorrect, make the necessary notations adjacent to each corresponding entry. This form is to be used to record data for one replenishment part. Duplication of this form is authorized to record data for other replenishment parts meeting the above conditions. If space is insufficient, use back side.

1. Replenishment part National Stock Number _____.

2. Replenishment part procurement history (Commodity Command Standard System, National Stock Number Master Data Record computer file is considered a valid source for this data). Provide contract number, date, quantity, unit of measure, and unit price (contract or line item price divided by contract or line item quantity). This data should be for <u>each purchase made before the first competitive procurement</u>.

3. Total charges incurred from developing a reverse engineered technical data package (TDP). All charges should be itemized as either Government or contractor. Estimated Government labor, materials, and overhead expenses <u>should not</u> be considered as sunk costs.
   a. Total contractor TDP development charges: $_____.
   b. Contract Number _____.
   c. Total Government TDP development charges: $_____.
   d. Number of selected replenishment parts _____.
   e. Number of replenishment parts reverse engineered _____.

4. Total charges incurred from conducting and reconducting first article testing (FAT). All charges should be itemized as either Government or contractor. Estimated Government labor, materials, and overhead expenses <u>should not</u> be considered as sunk costs.
   a. Total contractor FAT charges: $_____.
   b. Contract Number _____.
   c. Total Government FAT charges: $_____.
   d. Number of reverse engineered replenishment parts _____.
   e. Number of replenishment parts passing FAT _____.

5. Competitive replenishment contracts. Provide contract number, date, quantity, unit of measure, and unit price (contract or line item price divided by contract or line item quantity) for <u>each competitive replenishment contract awarded after FAT</u>.

6. Anticipated future replenishment contracts. Provide expected dates, quantities, units of measure, and unit prices (contract or line item price divided by contract or line item quantity) for all forecasted requirements.

ARMY REVERSE ENGINEERING PILOT PROGRAM VALIDATION DATA CALL
Part II of II
(prepare this form only once)

1. Provide a best estimate of the total number of National Stock Numbers that will be screened in order to complete an Army Reverse Engineering Program (may equal the number of stock numbers managed at your Command).

2. Provide a best estimate of the total number of National Stock Numbers that were screened to produce the replenishment parts recorded on Part I forms.

3. Provide a best estimate of the total number of National Stock Numbers that were selected (from the screened replenishment parts) for development of technical data packages.

4. Provide the total charges incurred from screening replenishment parts to identify potential reverse engineering candidates. All charges should be itemized as either Government or contractor. Government labor, materials, and overhead expenses should not be considered as sunk costs.

a. Total contractor screening charges: $_____.
b. Contract Number _____.
c. Total estimated Government screening charges: $_____.

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
ARMY PROCUREMENT RESEARCH OFFICE
FORT LEE, VIRGINIA 23801-6045

REPLY TO
ATTENTION OF

S: 23 Sep 88

SFRD-KPR (70-61a) 23 August 1988

MEMORANDUM FOR: Commander, U.S. Army Troop Support Command, 4300 Goodfellow Blvd, ATTN: AMSTR-ST, St. Louis, MO 63120-1798

SUBJECT: Data Call for Army Reverse Engineering Pilot Program Validation

1. The Army Procurement Research Office (APRO) has been tasked by the Army Materiel Command to validate reported cost savings for the Army Reverse Engineering Pilot Program.

2. Request that historical data be provided for each National Stock Number listed in the enclosure. The historical data should include date, quantity and unit price for each previous procurement. Requested data is available from Source of Supply designated as A12.

3. Requested data should be returned to the following address on or before 23 Sep 88:

Office of the Assistant Secretary of the Army (RDA)
Army Procurement Research Office
ATTN: SFRD-KPR (Mr. Worthington)
Building 12113
Fort Lee, VA 23801-6045

4. APRO points of contact are Mr. Tracy Worthington or Dr. Sagar Bakhshi at AV 687-1148/1404.

Wayne V. Zabel

Encl

WAYNE V. ZABEL
Director, U.S. Army
Procurement Research Office

LIST OF NATIONAL STOCK NUMBERS

1. 1670-00-027-0040
2. 2305-01-149-9242
3. 4930-01-170-7416
4. 5310-01-149-9255
5. 5310-01-149-9248
6. 5365-01-186-9935
7. 5365-01-186-9936
8. 6140-01-249-4085
9. 6140-01-249-4086
10. 6140-01-249-4087
11. 6140-01-248-9954
12. 7360-01-246-9259
13. 2590-01-246-9256
14. 7360-01-247-2367
15. 7360-01-160-3465
16. 7360-01-182-8812
17. 7360-01-184-0347

APPENDIX B

STATUS OF REVERSE ENGINEERED ITEMS COMPLETED REPORT

BY

BELVOIR RESEARCH AND DEVELOPMENT ENGINEERING CENTER

...rvation form
For use of this form see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
STRBE-TSX (70-1x)	Status of Reverse Engineering Items Completed

TO SEE DISTRIBUTION | FROM STRBE-TSX BELVOIR RD&E CENTER | DATE 07 JUL 1988 | CMT1 Ms. C. Bascomb/ES/5127

1. Reference DF dated 23 June 1988 from AMSTR-MFC to STRBE-TSP, subject: Status of Reverse Engineering Items Completed and reference DF dated 27 June 1988 from AMSTR-A to STRBE-TSP, subject: AMC SPRINT Data Call #21.

2. The following information is listed as requested in reference DFs:

a. Number of items initially screened to select candidates for the RE program:

152 Phase I
63 Phase II
215 Total

b. Number of items submitted to the contractor for RE after the initial screening:

8 Phase I
32 Phase II
40 Total

c. Total amount of dollars provided to-date to VSE for the RE effort on:

1. Vanguard Phase .....$ 1,016,065.00 (Includes $ from other MSC's)
2. Blossom Phase.....$ 595,088.00 (Includes $ from other MSC's)

d. Items that have been successfully reversed engineered for competition, date of completion and the incurred RE costs are as follows:

VANGUARD PHASE	NATIONAL STOCK NO.	COMPLETION DATE	RE COST
Fluid Filter Element	NSN 2945-01-115-9547	1 DECEMBER 1986	$26,918.00
Metal Washer	NSN 5310-01-149-9255	18 SEPTEMBER 1987	1,077.00
Jack Assy , Leveling	NSN 7360-01-246-9259	30 OCTOBER 1986	26,918.00
Cargo Net	NSN 1670-00-027-0040	14 SEPTEMBER 1987	5,384.00
Transducer,Pressure	NSN 2305-01-149-9242	18 SEPTEMBER 1987	2,153.00
Jack, Roof Lifting	NSN 7360-01-247-2367	18 SEPTEMBER 1987	32,302.00
Washer, Plastic	NSN 5301-01-149-9354	14 SEPTEMBER 1987	1,077.00

BLOSSOM PHASE	NATIONAL STOCK NO.	COMPLETION DATE	RE COST
Switch Cover	NSN 5930-01-126-4045	AUGUST 1987	$ 1,386.00
End, Strainer	NSN 4930-01-170-7416	OCTOBER 1987	3,045.00
Ring, Nozzle	NSN 4930-01-170-6925	NOVEMBER 1987	1,900.00
Deck Connector	NSN 5935-01-153-2288	JANUARY 1988	9,025.00
Intake Filter Element	NSN 2940-01-124-5458	DECEMBER 1987	11,464.00
Water Filter,Parts Kit	NSN 4610-01-162-5044	JANUARY 1988	3,636.00

AMSTR-TSX

SUBJECT: Status of Reverse Engineering Items Completed

e. All items in both phases were reverse engineered using Engineering Services.

f. For additional information contact Ms. Cathy Hancomb, STRBE-TSX, AV354-5127/5128.

HARRY L. HODGES
Chief, Producibility
Engineering Team

DISTRIBUTION:
AMSTR-MEC (J. Medrano)
AMSTR-MEC (George Lacanski)
AMSTR-A (Barbara Ternak)

APPENDIX C

TROSCOM REVERSE ENGINEERING AUDIT REPORT

Cmd

U.S. ARMY TROOP SUPPORT COMMAND
4300 Goodfellow Boulevard
St. Louis, Missouri 63120-1798

TROSCOM Report No. R-5-87

22 DEC 1987

SUBJECT: Reverse Engineering Program

1. AUTHORITY: AR 11-7 and the CY 87 Internal Review Program.

2. OBJECTIVE AND SCOPE: The objective of the audit was to evaluate the implementation of the Command's Reverse Engineering (RE) Program to ensure procedures for selection of RE candidates are adequate, and funds allocated are properly used and audit trails established. The audit also included review of the methodology used for computing return of investment on RE items and the accuracy of the computations. The audit, conducted during the period Apr through Jun 87 with a site visit to Belvoir Research, Development and Engineering Center (Belvoir), was performed in accordance with generally accepted government auditing standards.

3. BACKGROUND:

a. In FY 85, the Committee on Appropriations directed the Defense Department to establish a RE Pilot Program to increase competition for spare parts currently procured as sole source due to limited data rights. The program emphasized the utilization of contract support services to develop unencumbered technical data packages for the Government's use on a competitive basis; but is not intended to diminish in-house RE efforts that have demonstrated their usefulness. The Committee has a keen interest in this program and it is seen as an important action toward implementing the DoD Spare Parts Management Reforms. Based upon Congressional guidance, each service was required to implement a $5 million pilot RE program. TROSCOM had the lead for the Army's program.

b. In a 6 Jun 85 message from DA, AMC was provided $999,991 of FY 83 and $4 million of FY 84 procurement appropriation (PA) funds to accomplish the program. In Jul 85, AMC allocated the initial $999,991 to TROSCOM. In Aug 85, $943,868 was obligated by Belvoir on an existing VSE Corporation contract. The remaining $56,123 was obligated during Sep 85 for in-house engineering support. The $4 million was allocated as follows:

MSC	Funds Allocated
AVSCOM	$1,157,260
AMCCOM	276,239
TACOM	276,624
CECOM	564,580
MICOM	1,725,297
TOTAL	$4,000,000

c. The program involved all MSCs in an initial "Vanguard" phase, managed by TROSCOM. Vanguard was to end 1 Oct 86. Vanguard was extended during 1986 to Apr 88, and increased from $5 to $10 million. In Jan 87, Vanguard was followed by MSCs developing individual programs under a second "Blossom" phase which runs to the end of the pilot program. TROSCOM received $868,000 for "Blossom."

4. RESULTS OF AUDIT:

a. Executive Summary. Our audit concluded procedures for the selection of RE candidates were adequate, but improvements were needed in the management of funds for in-house engineering support and calculation of return on investment. Specifically, we found:

- increased emphasis on funds management was needed to identify excess funds (para 4c(1)), properly account for in-house support (para 4c(2)), ensure funds are used for their intended purpose (para 4c(3)), and in-house support of nonTROSCOM RE efforts is properly reimbursed (para 4c(4)); and

- not all RE costs were included in return on investment calculations (para 4d).

Details of these findings, our recommendations, and Command comments follow.

b. Funding. We concluded more oversight and better controls and procedures were needed over funds for in-house support.

(1) "Vanguard" required in-house engineering support by Belvoir. This support was estimated at $56,123 and was properly established as a project order under the provisions of AR 37-41 by the Competition Management Office (CMO). At the time of our audit, $18,327 had not been expended by Belvoir. Based upon the contractual effort remaining for "Vanguard" and the direct correlation between it and the in-house engineering support, we questioned the need for the $18,327. As a result of our questions, $14,124 was determined to be no longer needed. In Jul 87, CMO withdrew the $14,124 from Belvoir.

(2) In Jan 87, CMO provided Belvoir an additional $568,000 for "Blossom." Of this amount, $50,000 was estimated for in-house engineering support. However, the $50,000 was not established as a project order as the $56,123 had been. Based upon our recommendation, CMO established in Jul 87 a project order for the $50,000 that included a narrative specifying the contractual effort correlated to this in-house support and the requirement for quarterly reports on the status of the in-house support.

RECOMMENDATIONS: For the Chief, Competition Management Office

A. Review quarterly status reports to ensure unneeded funds are identified as early as possible.

CHIEF, COMPETITION MANAGEMENT OFFICE COMMENTS: Concur. However, effective 1 Apr 88, the Reverse Engineering Pilot Program is complete and funds will no longer be tracked by the Competition Management Office. Reverse Engineering efforts will have to be tracked by the individual office requesting this effort. Reviews of quarterly status reports, if required, and use of project orders will be the responsibility of these individual offices.

B. Make sure project orders are established for future in-house engineering support.

CHIEF, COMPETITION MANAGEMENT OFFICE COMMENTS: Concur. See comments to recommendation A above.

(3) Belvoir used $72,000 of the $568,000 "Blossom" funds to complete the work on five "Vanguard" items. The $72,000 was obligated on the VSE contract on 25 Feb 87. We believe these funds were improperly used. The $72,000 was Blossom funds and FY 86 PA funded, and should not have been used to complete Vanguard which was FY 83 PA funded. We were told AMC approved the use of these Blossom funds for Vanguard. However, we could not find any documentation of this approval.

RECOMMENDATION: For the Chief, Competition Management Office

C. In conjunction with Belvoir, determine the propriety of using Blossom (FY 86 PA funds) to complete Vanguard (FY 83 PA funds). If determined to be improper, initiate the required accounting adjustments to correct this 31 USC 1301 violation. Document the determination.

CHIEF, COMPETITION MANAGEMENT OFFICE COMMENTS: Concur. This expenditure was verbally authorized by AMC. This office will secure a written document from AMC authorizing this expenditure as requested. This written document will be requested no later than 31 Dec 87.

(4) Documentation was not available to support the funds held by Belvoir for in-house production engineering support of the RE efforts of the other MSCs participating in Blossom. At the time of our audit, Belvoir had awarded five task orders to the VSE contract DAAK70-86-D-0023 for RE for MICOM, AMCCOM, TACOM, TROSCOM, and DLA. TROSCOM's task order (0071) obligated for $444,695, was to evaluate 150 candidates and RE 20 of them. Belvoir withheld $50,000 for in-house support related to TROSCOM's task order. In contrast, MICOM's task order (0009), obligated for $291,163, was to evaluate 100 candidates and RE 40. Belvoir, however, only withheld $8,837 for in-house support related to MICOM's effort. AMCCOM's task order was for $264,035 and only $8,281 was held by Belvoir for in-house support. We believe the funds held in-house by Belvoir for nonTROSCOM RE efforts for Blossom needs to be evaluated. This evaluation is necessary to ensure TROSCOM is not absorbing other MSC/DLA costs since other MSC's/DLA were specifically funded for Blossom. In addition, this evaluation needs to be documented. Appropriate actions, to include requesting additional funds from the other MSCs/DLA, if determined to be appropriate, should be initiated as a result of the evaluation.

RECOMMENDATION: For the Commander, Belvoir RD&E Center (Directorate for Product Assurance and Engineering)

D. Evaluate the funding held in-house for nonTROSCOM RE efforts for Blossom. Document the evaluation and take appropriate actions as a result of the evaluation.

COMMANDER, BELVOIR RD&E CENTER COMMENTS: Concur. The Directorate for Product Assurance and Engineering evaluated the work efforts and expenditures of funds for in-house production engineering support relating to TROSCOM and nonTROSCOM Reverse Engineering (RE) efforts as follows. The administrative tasks performed by the Directorate for TROSCOM RE efforts included developing initial economic analysis of potential RE candidates; participating in the final candidate selection; coordinating and expediting item status reports; coordinating preliminary and final TDPs with project engineers (Natick and Belvoir); entering TDPs into Engineering Data Bank; and preparing reports on estiamted cost savings. In contrast, the in-house engineering support efforts expended on nonTROSCOM RE tasks were primarily limited to the transmitting of information to and from contractor and MSCs/Agency. The participating MSCs/Agency were responsible for their own analysis, item selection, and coordination. Due to the type and amount of work performed in supporting both classes of RE efforts (TROSCOM and nonTROSCOM), the differences in expenditures are justified. Request for additional RE funds from the MSCs/Agency does not appear appropriate.

d. Return on Investments (ROI). ROI calculations for Vanguard did not include all costs related to the RE effort. As a result, ROI's used in RE briefings did not accurately reflect the savings attributable to RE efforts.

The Following schedule provides details:

	Briefings			Difference
	Initial	Revised	Actual	Actual & Revised
Savings	$9,458,200	$9,458,200	$9,458,200	$ -0-
Costs:				
- RE by VSE	$265,955	$443,000	$515,000	$72,000
- Candidate Selection by VSE	-0-	-0-	345,000	345,000
- RE Handbook by VSE	-0-	-0-	156,000	156,000
- In-House Support by Belvoir	-0-	-0-	34,000	34,000
TOTAL COSTS	$265,955	$443,000	$1,050,000	$507,000
ROI (Savings: Costs)	35.6:1	21.4:1	9.0:1	12.4:1

$978,000 of the $1,050,000 was validated by Belvoir's Directorate for Resource Mangement's Cost Analysis Division. The remaining $72,000 was additional costs to complete Vanguard (para 4c(3)) which were excluded from the validation. All costs and savings attributable to RE should be included in ROI calculations to ensure RE briefings are as accurate as possible.

RECOMMENDATION: For the Chief, Competition Management Office

E. Make sure all known costs attributable to RE are included in ROI calculations.

CHIEF, COMPETITION MANAGEMENT OFFICE COMMENTS: Concur with your recommendation less the RE handbook by VSE per guidance of AMC, Competition Management Office. Effective 14 Dec 87, future ROI calculations will include all known costs.

for Frank J. Bono
CHAD DIVINCENZO
Auditor, Internal Review and
Audit Compliance Office

Frank J. Bono
FRANK J. BONO
Chief, Internal Review and
Audit Compliance Office

27 Jan 1988

[X] Approved [ ] Disapproved [ ] Other

AMCPP-MC (715)

03 FEB 1988

MEMORANDUM FOR: Commander, U.S. Army Troop Support Command, ATTN: AMSTR-A (Mrs. Barbara Cernak), 4300 Goodfellow Blvd., St. Louis, MO 63120-1798

SUBJECT: Audit of Pilot Reverse Engineering Program

1. Reference memorandum, HQ TROSCOM, AMSTR-A, 29 Dec 87, SAB.

2. Responding to paragraph 2 of referenced letter, a decision was made by this office to utilize Blossom phase dollars to complete Vanguard items. This decision was made during a phone call between the project officer for the AMC Reverse Engineering Pilot Program (Mr. Loren Anderson) and LTC D. Bryant, who at the time was the Chief of the TROSCOM Competition Management Office. The rationale for this decision was that it would be foolish to leave items that had been partly reverse engineered incomplete because we had run out of Vanguard dollars.

3. Concurrence is granted in the position taken by your office relating to Return on Investment.

4. AMC - Providing Soldiers the Decisive Edge.

FOR THE COMMANDER:

SIGNED

RONALD H. KUHN
Chief, Competition
Management Office

Dir/File Name: loren-audit

MR. ANDERSON/AMCPP-MC/dld/45685

APPENDIX D

PROCUREMENT HISTORY, REVERSE ENGNEERING COSTS, AND SAVINGS ESTIMATES FOR INDIVIDUAL ITEMS

Table 1. Savings Estimates for Fluid Filter Element

Item: Fluid Filter Element NSN: 2945-01-115-9547

Procurement History before RE

Julian Date	Quantity	Unit Price
88084	5000	$ 62.50
83348	2048	72.50
83179	1543	73.50
83069	79	116.80
83062	648	116.80

Procurement History after RE

Julian Date	Quantity	Unit Price
88032	8400	$ 19.20

Savings Estimates

Savings per Item = $62.50 - $19.20 = $43.30

Expected yearly demand = 2313 units

Expected Life Cycle = 15 years

Instant Savings (Savings per Unit x Number of Units Procured)

= $43.30 x 8400 = $363,720

	AMC Estimates	APRO Estimates	Difference (AMC - APRO)
Instant Savings	$ 448,140	$ 363,720*	$ 84,420
5-year Savings	618,807	500,765	118,042
Life Cycle Savings	1,843,776	1,502,294	341,482

Reverse Engineering Cost

Direct	$26,918
Indirect	50,958
Total	77,876

* The difference is due to the unit price of the previous buy. AMC report used $72.70 whereas APRO used $62.50.

Table 2. Savings Estimates for Metal Washer

Item: Metal Washer NSN: 5310-01-149-9255

Procurement History before RE

Julian Date	Quantity	Unit Price
84272	3260	$2.5100

Procurement History after RE

Julian Date	Quantity	Unit Price
87342	1845	$ .8366

Savings Estimates

Savings per Item = $2.51 - $ .8366 = $1.6734

Expected yearly demand = 650 units

Expected Life Cycle = 20 years

Instant Savings (Savings per Unit x Number of Units Procured)

= $1.6734 x 1845 = $3,087.42

	AMC Estimates	APRO Estimates	Difference (AMC - APRO)
Instant Savings	$ 3,087	$ 3,087	$ 0
5-year Savings	5,438	5,439	-1
Life Cycle Savings	21,750	21,754	-1

Reverse Engineering Cost

Direct	$1,077
Indirect	2,039
Total	3,116

Table 3. Savings Estimates for Leveling Jack Assembly

Item: Leveling Jacck Assembly NSN: 7360-01-246-9259

Procurement History before RE

Julian Date	Quantity	Unit Price
85143	9	$265.00*

Procurement History after RE

Julian Date	Quantity	Unit Price
87138	300	$105.00

Savings Estimates

Savings per Item = $265.00 - $105.00 = $160.00

Expected yearly demand = 200 units

Expected Life Cycle = 20 years

Instant Savings (Savings per Unit x Number of Units Procured)
= $160 x 300 = $48,000

	AMC Estimates	APRO Estimates	Difference (AMC - APRO)
Instant Savings	$ 48,000	$ 48,000	$ 0
5-year Savings	160,000	160,000	0
Life Cycle Savings	640,000	640,000	0

Reverse Engineering Cost

Direct	$26,918
Indirect	50,958
Total	77,876

*This is the procurement price of NSN 7360011884533 which was replaced by 7360-01-246-9259.

Table 4. Savings Estimates for Cargo Net.

Item: Cargo Net NSN: 1670-00-027-0040

Procurement History before RE

Julian Date	Quantity	Unit Price
88041	1	$3,335.00
84283	85	595.00
83221	34	642.60
83068	25	642.60
82354	21	634.50
82293	21	634.50
80311	64	524.60
80022	89	510.00
79085	32	463.60
78081	8	576.20
76055	10	637.40
75055	49	607.80
74270	10	584.50
73325	27	422.50

Procurement History after RE

Julian Date	Quantity	Unit Price
88041	356	$526.84

Savings Estimates

Savings per Item = $595.00 - $526.84 = $68.16

Expected yearly demand = 35 units

Expected Life Cycle = 20 years

Instant Savings (Savings per Unit x Number of Units Procured)

= $68.16 x 356 = $24,264.96

	AMC Estimates	APRO Estimates	Difference (AMC - APRO)
Instant Savings	$ 24,265	$ 20,930*	$3,335
5-year Savings	11,928	11,928	0
Life Cycle Savings	47,712	47,712	0

Reverse Engineering Cost

Direct	$ 5,384
Indirect	10,192
Total	15,576

* Instant Savings are adjusted by the cost of first article.

Table 5. Savings Estimates for Pressure Transducer

Item: Pressure Transducer NSN: 2305-01-149-9242

Procurement History before RE

Julian Date	Quantity	Unit Price
84353	69	$439.10
83200	38	452.90
83189	2	538.20

Procurement History after RE

Julian Date	Quantity	Unit Price
87187	28	$345.00
88015	28	319.00

Savings Estimates

Savings per Item = $439.10 - $345.00 = $94.10

Expected yearly demand = 45 units

Expected Life Cycle = 20 years

Instant Savings (Savings per Unit x Number of Units Procured)

= $94.10 x 28 = $2634.80

	AMC Estimates	APRO Estimates	Difference (AMC - APRO)
Instant Savings	$ 2,636	$ 2,635	$ 1
5-year Savings	21,150	21,173	-23
Life Cycle Savings	84,600	84,690	-90

Reverse Engineering Cost

Direct	$2,153
Indirect	4,076
Total	6,229

Table 6. Savings Estimates for Roof Lifting Jack

Item: Roof Listing Jack NSN: 7360-01-247-2367

Procurement History before RE

Julian Date	Quantity	Unit Price
86106 ◦	933	$159.00
Unknown	Unknown	504.00

Procurement History after RE

Julian Date	Quantity	Unit Price
87138	1000	$139.00

Savings Estimates

Savings per Item = $159.00 - $139.00 = $20.00

Expected yearly demand = 405 units

Expected Life Cycle = 20 years

Instant Savings (Savings per Unit x Number of Units Procured)

= $20 x 1000 = $20,000

	AMC Estimates	APRO* Estimates	Difference (AMC - APRO)
Instant Savings	$ 365,000	$ 20,000	$ 345,000
5-year Savings	739,125	40,500	698,625
Life Cycle Savings	2,956,500	162,000	2,794,500

Reverse Engineering Cost

Direct	$30,302
Indirect	61,150
Total	91,452

*The difference in estimates is due to the unit price paid during the previous buy. AMC used $504 whereas APRO used $159.

Table 7. Savings Estimates for Plastic Washer

Item: Plastic Washer NSN: 5301-01-149-9354

Procurement History before RE

Julian Date	Quantity	Unit Price
84272	3260	Unknown

Procurement History after RE

Julian Date	Quantity	Unit Price
88057	2959	$2.40

Savings Estimates

Savings per Item = Unknown

Expected yearly demand = 626 units

Expected Life Cycle = 5 years

Instant Savings (Savings per Unit x Number of Units Procured)

= Unknown

	AMC Estimates	APRO* Estimates	Difference (AMC - APRO)
Instant Savings	$ 1,775	Unknown	Unknown
5-year Savings	1,879	Unknown	Unknown
Life Cycle Savings	1,879	Unknown	Unknown

Reverse Engineering Cost

Direct	$1,077
Indirect	2,039
Total	3,116

*Estimated savings cannot be calculated because price paid before reverse engineering is not available.

Table 8. Savings Estimates for End Strainer Assembly

Item: End Strainer Assembly NSN: 4930-01-170-7416

Procurement History before RE

Julian Date	Quantity	Unit Price
87127	526	$35.22
85255	178	33.90
85123	58	31.60

Procurement History after RE

Julian Date	Quantity	Unit Price
88069	469	$10.28

Savings Estimates

Savings per Item = $35.22 - $10.28 = $24.94

Expected yearly demand = 172 items

Expected Life Cycle = 10 years

Instant Savings (Savings per Unit x Number of Units Procured)

= $24.94 x 469 = $11,696.86

	AMC Estimates	APRO* Estimates	Difference (AMC - APRO)
Instant Savings	$11,697	$11,697	$ 0
5-year Savings	21,448	21,448	0
Life Cycle Savings	42,897	42,897	0

Reverse Engineering Cost

Direct	$3,045
Indirect	882
Total	3,927

Table 9. Savings Estimates for Halfpenny Washer

Item: Halfpenny Washer NSN: 5310-01-149-9248

Procurement History before RE

Julian Date	Quantity	Unit Price
85128	8228	$0.7924
84271	6500	0.9404

Procurement History after RE

Julian Date	Quantity	Unit Price
88005	3918	$0.6375

Savings Estimates

Savings per Item = $0.7924 - $0.6375 = $0.1549

Expected yearly demand = 3012 items

Expected Life Cycle = 8 years

Instant Savings (Savings per Unit x Number of Units Procured)

= $0.1549 x 3918 = $606.89

	AMC Estimates	APRO* Estimates	Difference (AMC - APRO)
Instant Savings	$ 607	$ 607	$ 0
5-year Savings	2,333	2,333	0
Life Cycle Savings	3,732	3,732	0

Reverse Engineering Cost

Direct	$104 (In-house)
Indirect	0
Total	104

Table 10. Savings Estimates for Lead Storage Battery

Item: Lead Storage Battery NSN: 6140-01-249-4085

Procurement History before RE

Julian Date	Quantity	Unit Price
No Previous History		

Procurement History after RE

Date	Quantity	Unit Price
88039	590	$6.03

Savings Estimates

Savings per Item = Unknown

Expected yearly demand = 237 items

Expected Life Cycle = Unknown

Instant Savings (Savings per Unit x Number of Units Procured)

= Unknown

	AMC Estimates	APRO* Estimates	Difference (AMC - APRO)
Instant Savings	$ 889	Unknown	Unknown
5-year Savings	1,784	Unknown	Unknown
Life Cycle Savings	3,568	Unknown	Unknown

Reverse Engineering Cost

Direct	$442 (In-house)
Indirect	0
Total	442

Table 11. Savings Estimates for Spacer Plate

Item: Spacer Plate NSN: 5365-01-186-9935

Procurement History before RE

Julian Date	Quantity	Unit Price
87264	907	$2.65
85116	1227	3.73
84354	252	4.52

Procurement History after RE

Date	Quantity	Unit Price
88067	2254	$1.00

Savings Estimates

Savings per Item = $2.65 - $1.00 = $1.65

Expected yearly demand = 1176 items

Expected Life Cycle = 10 years

Instant Savings (Savings per Unit x Number of Units Procured)

= $1.65 x 2254 = $3,719.10

	AMC Estimates	APRO* Estimates	Difference (AMC - APRO)
Instant Savings	$ 3,719	$ 3,719	$ 0
5-year Savings	9,702	9,702	0
Life Cycle Savings	19,404	19,404	0

Reverse Engineering Cost

Direct	$104 (In-house)
Indirect	0
Total	104

Table 12. Savings Estimates for Spacer Plates

Item: Spacer Plates NSN: 5365-01-186-9936

Procurement History before RE

Julian Date	Quantity	Unit Price
87208	2671	$ 5.75
85116	225	4.38
84354	300	4.47

Procurement History after RE

Julian Date	Quantity	Unit Price
88057	2000	$1.24

Savings Estimates

Savings per Item = $5.75 - $1.24 = $4.51

Expected yearly demand = 1212 items

Expected Life Cycle = 10 years

Instant Savings (Savings per Unit x Number of Units Procured)

= $4.51 x 2000 = $9,020

	AMC Estimates	APRO* Estimates	Difference (AMC - APRO)
Instant Savings	$ 9,020	$ 9,020	$ 0
5-year Savings	27,331	27,331	0
Life Cycle Savings	54,661	54,661	0

Reverse Engineering Cost

Direct	$104	(In house)
Indirect	0	
Total	104	

APPENDIX E

LIST OF ITEMS REVERSE ENGINEERED DURING BLOSSOM PHASE

BLOSSOM PHASE:

ITEM NOMENCLATURE
Switch Cover
End Strainer
Ring Nozzle Assembly
Deck Connector
Intake Filter Element
Electronic
IR Lite Kit
Air Filter, Element
Seat, Assembly
Shaft, Injector Pump
Hatch Latch Assembly

BLOSSOM PHASE (In-House at TROSCOM):

ITEM NOMENCLATURE	ITEM NOMENCLATURE
Tool Kit Service	Lead, Storage Battery
Battery Charger	Latch
Lower Bearing	Spacer, Plate
Lower Bearing	Washer, Fender
Bulkhead Tee	Washer, Halfpenny
Windshield Blade	Spacer, Plate
Cable Assembly	Washer, Plate
Engine Fuel Tank	Guard, Mechanical Drive
Lead, Storage Battery	Ring, Tiedown
Lead, Storage Battery	Spring, Leaf
Lead, Storage Battery	Rod, Upper Operating

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Army Materiel Command (AMC) was assigned the responsibility to establish and monitor the Army Reverse Engineering Pilot Program (AREPP). AMC selected the replenishment parts for reverse engineering, contracted out the reverse engineering tasks and used the technical data packages developed under this program to make competitive reprocurements. This study validates the reported AREPP savings.

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